25 Jan 1960

APPENDIX ______:

REQUIRED FILM CAPACITY

Introduction

The film area required for a mission is important for two reasons: The weight is directly proportional to the area; and the required space for film spools depends on the area. The required area can be calculated in various ways, but it is most valuable to calculate the required area directly in terms of those parameters which can be varied. In the case of this system, the parameters are: Flight-line miles covered with stereo overlap; flight-line miles covered with non-stereo overlap; percent of stereo overlap; angle of transverse scan; and the percent of the total film area utilized by photographic images.

Analysis

The total film area required (A_F) is equal to the product of the total number of frames required (N_F) and the film area per frame (a_f). A frame is that section of film required for the image (i.e. photographic format) and the surrounding border (see figure ____ - 1). Since the actual photographic image requires a smaller area (a_p), this area may be expressed as a percent utilization of the film area per frame (P_u).

That is,

$$A_F = N_F a_f .$$

But

$$a_p = P_u a_f$$

So

$$A_F = N_F \frac{a_p}{P_u} \qquad \text{\_\_\_\_ - 1}$$

The total number of frames required by the system of two camera units (N_F) is the sum of the number of frames required by either camera unit when operating alone (N_1) and the number of frames required by both

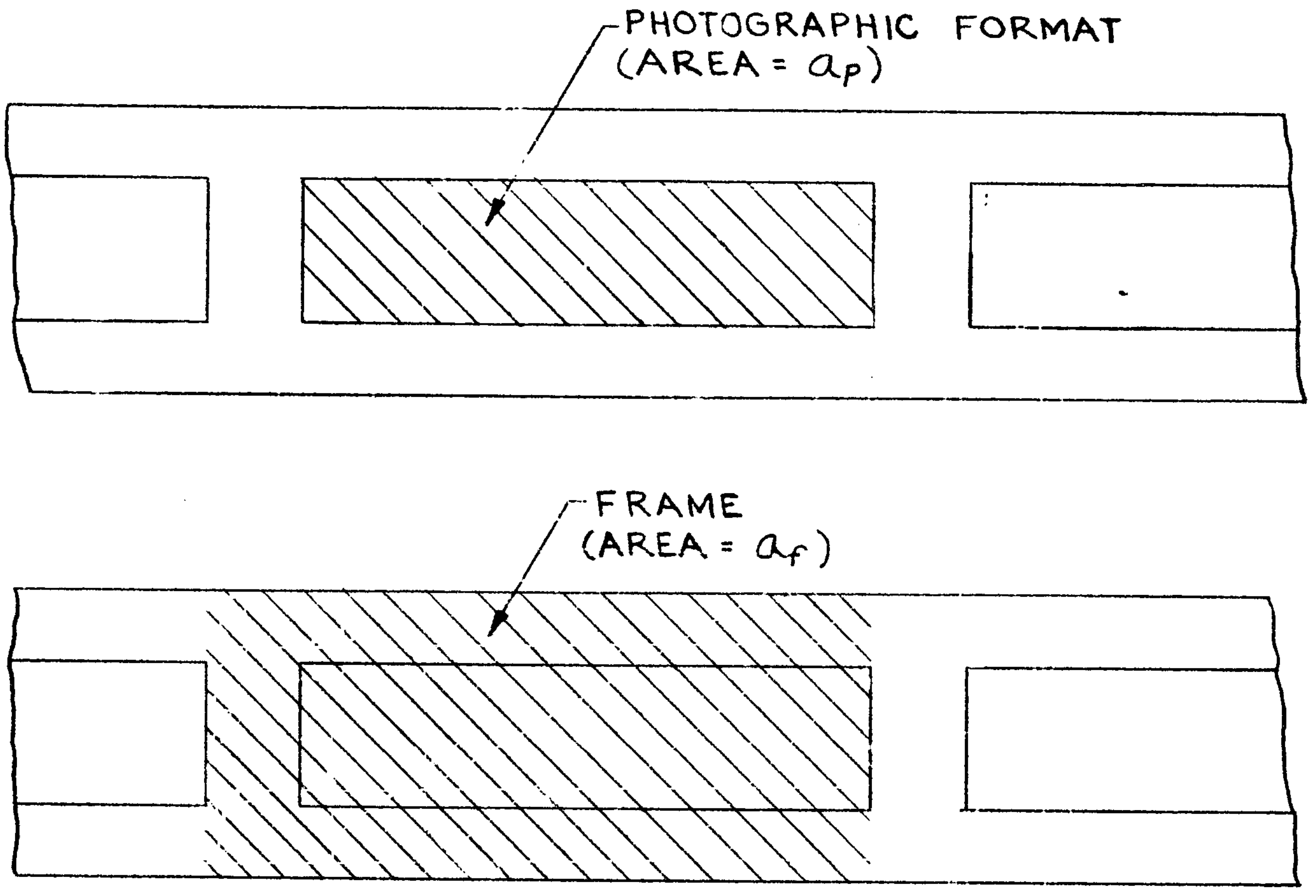


FIGURE -1: RELATION OF PHOTOGRAPHIC FORMAT
AND FILM FRAME

cameras when operating as a stereo pair (N_2). Stereo pair operation will be conducted for a number of flight-line miles (y_2) and will require a density of frames per flight-line mile (σ_2). To conserve film, one camera unit may be turned off when non-critical areas are being traversed, and the number of flight-line miles covered in this manner (y_1) will be covered with a density of frames per flight-line mile (σ_1) that is one-half the density for stereo coverage.

That is,

$$
\begin{aligned}
N_F &= N_1 + N_2 \\
N_1 &= \sigma_1 y_1 , \\
N_2 &= \sigma_2 y_2 , \\
\sigma_1 &= 1/2 \, \sigma_2 ,
\end{aligned}
$$

and therefore,

$$N_F = \sigma_2 \left(\tfrac{1}{2} y_1 + y_2 \right) .$$

The density of frames per flight-line mile (σ_2) when covered by stereo overlap of a given percentage (P_{OL}) is the ratio of one mile to the new terrain covered by the next frame (see figure ____ - 2). Since the distance along the flight-line covered by one frame (y_f) is known (see Appendix ____), the density can be calculated from

$$\sigma_2 = \frac{1}{(1 - P_{OL}) \, y_f} ,$$

and

$$N_F = \frac{y_1 + 2y_2}{2(1 - P_{OL}) \, y_f} . \qquad \text{\_\_\_\_ - 2}$$

The area of the photographic format (a_p) is determined by the imaging nature of the camera. For a panoramic coverage, the format length transverse to flight (L_x) is the product of the focal length (f) and the angle of scan (θ_S). The perpendicular dimension (L_y) is dependent on the field of view (θ_f) and focal length (see figure ____ - 3),

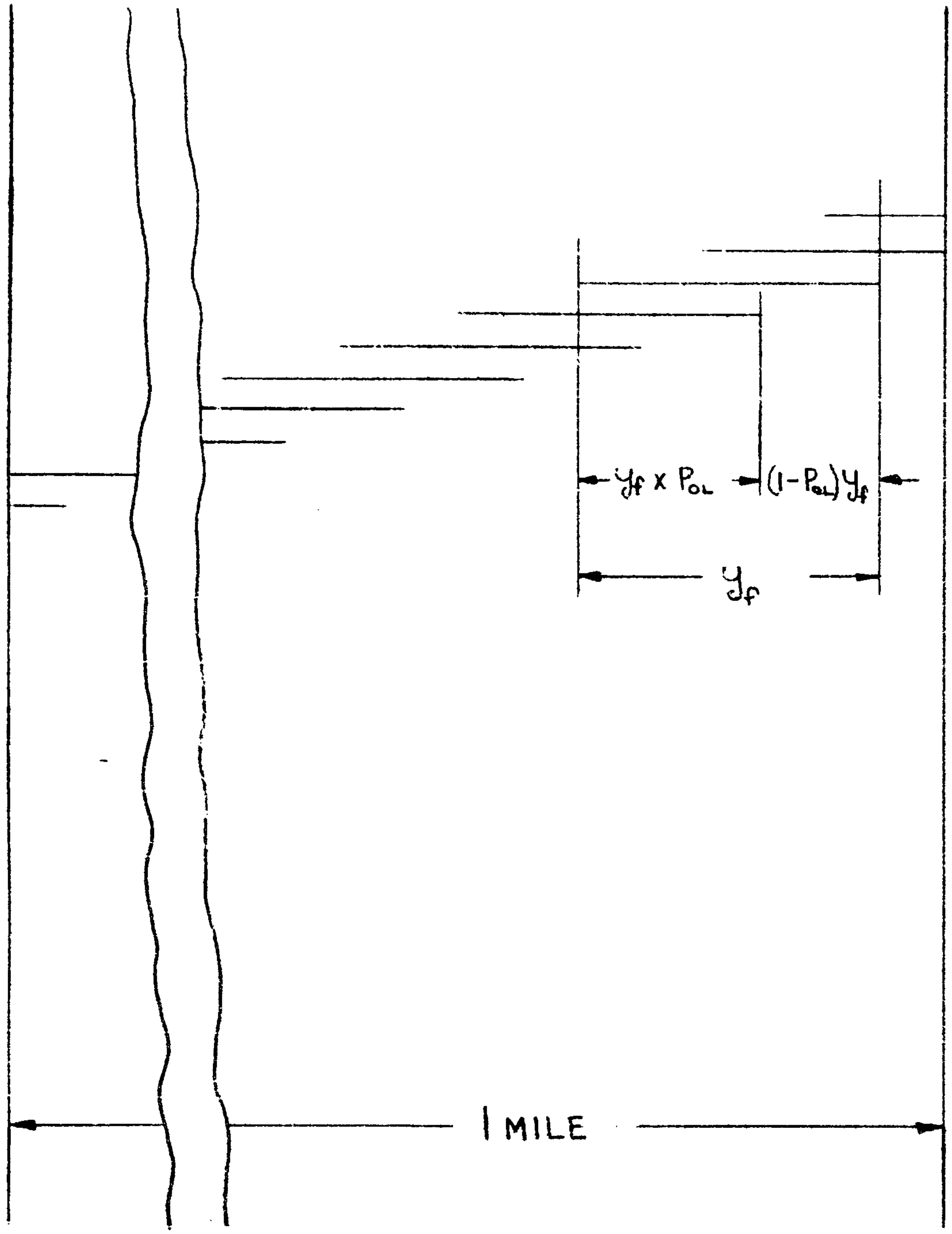
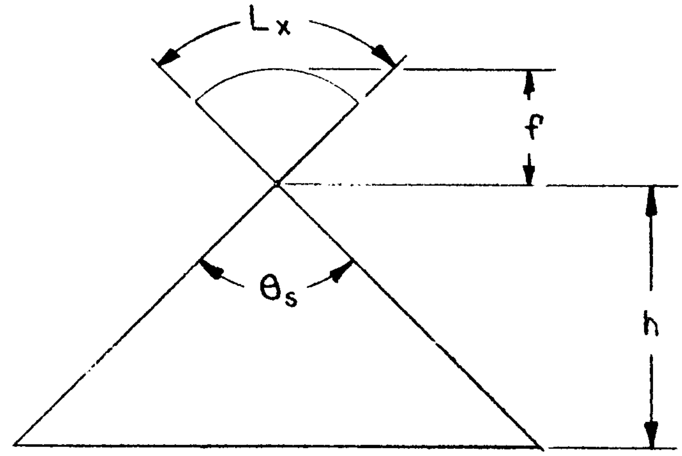
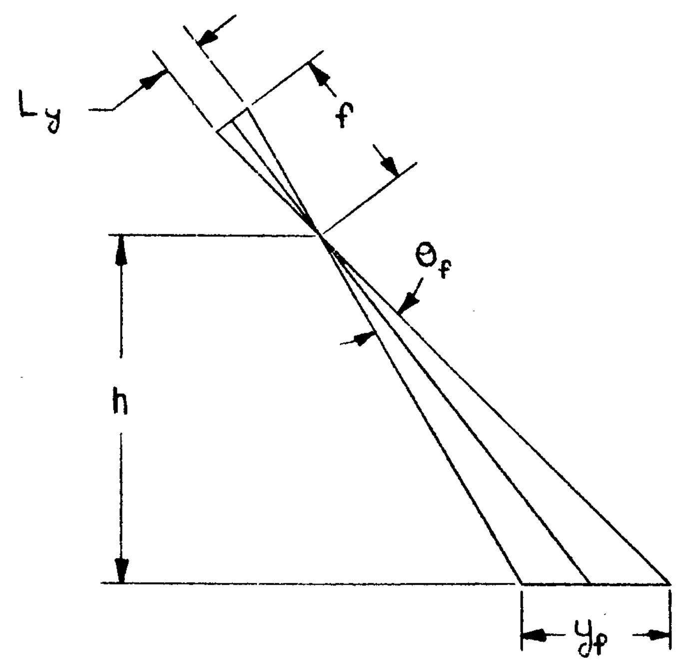


FIGURE -2: DIAGRAMMATIC REPRESENTATION OF GROUND COVERAGE



(a.) Transverse dimension (L_x)



(b.) Longitudinal dimension (L_y)

FIGURE ____ -3: PHOTOGRAPHIC FORMAT SIZE and can be calculated from

$$\frac{1}{2} L_y = f \operatorname{Tan} \frac{\theta_f}{2} \quad .$$

Since,

$$L_x = f\theta_s$$

and

$$a_p = L_x L_y$$

it is apparent that

$$a_p = (f\theta_s)\left(2f \operatorname{Tan} \frac{\theta_f}{2}\right) \qquad \text{\_\_\_\_ - 3}$$

The percentage utilization (P_u) of the film by photographic images depends on film size, cycling method, film transport, data presentation, amount of leader and trailer, and pre-flight and post-flight requirements. Therefore, a definite expression for utilization is impossible at this time, but a value of 90-95% seems reasonable.

<u>Conclusion</u>

Combining equations ____ - 1, ____ - 2, and ____ - 3, the required film area can be expressed as

$$A_F = \frac{(y_1 + 2y_2)\,\theta_s f^2 \operatorname{Tan} \frac{\theta_f}{2}}{y_f\,(1 - P_{oL})\,P_u} \qquad \text{\_\_\_\_ - 4}$$